POINTING DEVICE WITH FORCED FEEDBACK BUTTON

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of co-pending parent patent applications Ser. No. 09/156,802, filed Sep. 17, 1998 on behalf of Shahoian et al., entitled, "Improvements in Haptic Feedback Control Devices," and Ser. No. 09/103,281, filed Jun. 23, 1998 on behalf of Louis Rosenberg, entitled, "Low Cost Force Feedback Device with Actuator for Non-Primary Axis," both assigned to the assignee of this present application, and both of which are incorporated by reference herein in their entirety.

BACKGROUND OF THE INVENTION

The present invention relates generally to interface devices for allowing humans to interface with computer systems, and more particularly to computer interface devices that allow the user to provide input to computer systems and allow computer systems to provide force feedback to the user.

A user can interact with an environment displayed by a computer to perform functions and tasks on the computer, such as playing a game, experiencing a simulation or virtual reality environment, using a computer aided design system, operating a graphical user interface (GUI), etc. Common human-computer interface devices used for such interaction include a joystick, mouse, trackball, steering wheel, stylus, tablet, pressure-sensitive sphere, or the like, that is connected to the computer system controlling the displayed environment. Typically, the computer updates the environment in response to the user's manipulation of a physical manipulandum such as a joystick handle or mouse, and provides visual and audio feedback to the user utilizing the display screen and audio speakers. The computer senses the user's manipulation of the user object through sensors provided on the interface device that send locative signals to the computer. For example, the computer displays a cursor or other graphical object in a graphical environment, where the location of the cursor is responsive to the motion of the user object.

In some interface devices, tactile and/or haptic feedback is also provided to the user, more generally known as "force feedback." These types of interface devices can provide physical sensations which are felt by the user manipulating a user manipulandum of the interface device. For example, the Logitech Wingman Force joystick controller from Logitech, Inc. or the Feelit Mouse from Immersion Corporation may be connected to a computer and provides forces in the degrees of freedom of motion of the joystick or mouse to a user of the controller. One or more motors or other actuators are coupled to the joystick or mouse and are connected to the controlling computer system. The computer system controls forces on the joystick or mouse in conjunction and coordinated with displayed events and interactions by sending control signals or commands to the actuators. The computer system can thus convey physical force sensations to the user in conjunction with other supplied feedback as the user is grasping or contacting the physical object of the interface device. For example, when the user moves the manipulatable object and causes a displayed cursor to interact with a different displayed graphical object, the computer can issue a command that causes the actuator to output a force on the physical object, conveying a feel sensation to the user.

One problem with current force feedback controllers in the home consumer market is the high manufacturing cost of such devices, which makes the devices expensive for the consumer. A large part of this manufacturing expense is due to the inclusion of multiple actuators and corresponding control electronics in the force feedback device. In addition, high quality mechanical and force transmission components such as linkages and bearings must be provided to accurately transmit forces from the actuators to the user manipulandum and to allow accurate sensing of the motion of the user object. These components are complex and require greater precision in their manufacture than many of the other components in an interface device, and thus further add to the cost of the device. A need therefore exists for a force feedback device that is lower in cost to manufacture yet offers the user force feedback to enhance the interaction with computer applications.

SUMMARY OF THE INVENTION

The present invention is directed to a low-cost interface device connected to a computer system, the interface device having a simple actuator for low cost force feedback for enhancing interactions and manipulations in a displayed graphical environment.

More specifically, the present invention relates to a force feedback interface device that is coupled to a host computer system which implements a host application program. In one embodiment, the force feedback device is a mouse that is physically contacted by a user and movable in a planar workspace. The mouse includes a sensor device able to detect the movement of said mouse in the planar workspace and to output sensor signals representative of that movement. A button is coupled to a housing of the mouse, and a sensor detects a position of the button, such that when the button is pressed by the user to a predetermined position, a command signal is sent to the host computer. An actuator coupled to the button of the mouse and operative to apply an output force in the degree of freedom of the button. Preferably, a linear voice coil actuator is used. The button sensor can be a contact switch or a continuous-range sensor. The output force is preferably correlated with interaction of a controlled cursor with other graphical objects in a graphical environment displayed by the host computer. The force can be a jolt, vibration, constant force, texture force, or other type of force.

In a different embodiment, a force feedback pointing device having a cylindrical member is described. The cylindrical member is physically contacted by a user and may be rotated about an axis and translated along that axis to provide sensor signals representative of the rotation and translation. The sensor signals are used by the host computer to control a position of a graphical object in a displayed graphical environment, such as a cursor. The rotation controls one axis of motion of the cursor, such as vertical, and the translation controls a second axis of motion of the cursor, such as horizontal. A command sensor is also provided that detects a motion of the cylindrical member in a degree of freedom approximately perpendicular to the translation, such that when the cylindrical member is pressed by the user to a predetermined position in the perpendicular degree of freedom, a command signal is sent to the host computer. Finally, an actuator applies an output force in the perpendicular degree of freedom of the cylindrical member. The output force is correlated with an interaction of the cursor with a different graphical object in the graphical environment.

The present invention advantageously provides a force feedback device that is significantly lower in cost than other